

INTRODUCTION

In response to market needs, requests from previous graduates, and recommendations of external reviewers, the department is launching a new PhD program in geology. The program has been approved by the university board in June, 2009, and will be started in the second semester of 2009-2010. Prospective PhD students can start applying for the program, as part- or full-time through the website of the deanship of graduate studies <http://www.kfupm.edu.sa/gs/>.

The program reflects, and builds upon the Department's long-standing vision: *to continue as the leading Geosciences Department in the region through a balanced approach between education and research.*

Objectives: The main objectives of the Ph.D. Geology program are:

1. To prepare the students for publishable independent research and provide them with the technical expertise and skills needed to gather, interpret and report Earth Sciences data in a scientific manner;
2. To provide students with the necessary tools to effectively communicate the results of geological investigations to other professionals and the public;
3. To enhance distinction and professional ethics in the areas of natural resources, including oil and gas, groundwater, mineral resources, environment and geological engineering;
4. To prepare the students to serve their local community and the global community, to promote worldwide science and technology.

Major and Minor Areas: The Ph.D. program is offered in three Major Areas, each of them having several specializations ("Minor Areas"):

1. Petroleum Geology (Minor Areas: Paleontology, Clay Mineralogy, Basin Analysis, Reservoir Characterization, Petroleum Exploration, Exploration Geophysics, etc.)
2. Hydrogeology & Environmental Geology (Minor Areas: Numerical Modeling, Flow in Porous Media, Geostatistics, etc.)
3. Structural & Regional Geology (Minor Areas: GIS, Remote Sensing, Economic Geology, etc.).

ELIGIBILITY FOR ADMISSION, AND DEGREE PLAN

Eligibility:

- Applicants should hold an MSc degree in any field of *Earth Sciences* with a GPA of 3.0 or higher (or its equivalent) from reputable Institutions.

- They should meet KFUPM & Departmental standards of performance in the GRE advanced test in Geology, and in the TOEFL score.
- In case of *part-time students* there is an altogether one full year residency requirement, with full release from work duties.

Degree Plan:

The PhD Student will take

- 2 compulsory Core Courses from the GEOL6XX list (i.e.: GEOL 601 *Carbonate Sedimentology & Diagenesis*; GEOL 602 *Global & Regional Tectonics*; 3 Earth Sciences Elective Courses from their Major Area (GEOL 6XX, GEOL 5XX, GEOP 5XX or ENV5 5XX) provided such courses, or their equivalent, had not been already taken during his M.Sc. studies
- 3 Free Elective Courses from the 6XX or 5XX Courses offered by the ESD or from other Depts. of the KFUPM College of Sciences, College of Comp.Sci. & Engng., or College of Engng. Sciences.

Degree Plan of the PhD geology Program

Semester	Course Number and Title	Lec.	Lab	Cr
First Semester	Geol 601 (Carbonate Sed. and Diagenesis)	2	3	3
	Geol/Geop 5XX/6XX (<i>Earth Sciences Elective 1</i>)	3	0	3
	XXX 5XX/6XX (<i>Free Elective 1</i>)	3	0	3
		8	3	9
Second Semester	Geol 602 Global and Regional Tectonics	3	0	3
	Geol/Geop 5XX/6XX (<i>Earth Sciences Elective 2</i>)	3	0	3
	XXX 5XX/6XX (<i>Free Elective 2</i>)	3	0	3
		9	0	9
Third Semester	Geol/Geop 5XX/6XX (<i>Earth Sciences Elective 3</i>)	3	0	3
	Geol/Geop 5XX/6XX (<i>Earth Sciences Elective 4</i>)	3	0	3
	Geol 696 Doctoral Seminar	1	0	0
		7	0	6
Fourth Semester	Geol/Geop 5XX/6XX (<i>Earth Sciences Elective 5</i>)	3	0	3
	XXX 5XX/6XX (<i>Free Elective 3</i>)	3	0	3
		6	0	6
Fifth Semester	Geol 710 Ph.D Dissertation	0	0	IP
Sixth Semester	Geol 710 Ph.D Dissertation	0	0	12
Total			42	

GEOL 6XX COURSE DESCRIPTIONS

GEOL 601 Carbonate Sedimentology & Diagenesis (2-3-3) Processes of deposition of carbonate sediments. Recent environments as analogues for ancient carbonate sequences. Petrology and petrography of modern and ancient carbonate rocks, the reconstruction of their physical/chemical depositional and diagenetic environments in time and space. Major near-surface diagenetic environments, subaerial exposure, dolomitization, burial diagenesis. Carbonate aqueous equilibria, and carbonate geochemistry of trace elements and stable isotopes. Laboratories are devoted to thin-section analysis and hand-specimen study of

carbonate sediment and rocks, carbonate classifications, studying carbonate facies, models, and carbonate diagenesis. Field trips required.

Prerequisite: GEOL 533 (or equivalent) or consent of the instructor.

GEOL 602 Global & Regional Tectonics (3-0-3) Emphasis will be placed on crustal dynamics, plate tectonics and driving forces, evolution of collisional, transform and extensional systems, and dynamic indicators of past and current tectonic processes on global and regional level.

Prerequisite: GEOL 502 (or equivalents) or consent of the instructor.

GEOL 615 Advanced Basin Analysis (3-0-3) An interdisciplinary integration of geodynamics, mathematical and physical modeling, and sedimentary geology. Emphasizes basin formation, nature and maturation of the basin fill, and timing of events. Theoretical and computational basin models. Case histories of various basins illustrate approaches. Field trips required.

Prerequisite: GEOP 530 (or equivalent) or consent of the instructor.

GEOL 620 Advanced Hydrogeochemistry (3-0-3) Chemical principles applied to the understanding of factors controlling groundwater composition with an emphasis on water-mineral reactions. Introduction to chemical equilibrium computer modeling programs.

Prerequisite: GEOL551 (or equivalent) or consent of the instructor.

GEOL 630 Advanced Quantitative Hydrogeology (3-0-3) Overview of groundwater modeling techniques with environmental and geologic applications. Interaction of geology and subsurface groundwater flow. Basin hydrology modeling. Practical experience in computer simulations of subsurface hydrogeologic processes. Computer models will be developed and used for simulation of the fate and transport of pollutants in streams, lakes, and estuaries.

Prerequisite: GEOL 561 or GEOL562 (or equivalent) or consent of the instructor.

GEOL 640 Clastic Sedimentology & Diagenesis (2-3-3): Description and interpretation of sediments in ancient and modern depositional environments; Post-depositional alteration of sandstones and shales with emphasis on process-oriented controls on mineral reaction and porosity/permeability modification; Origin, distribution and evolution of clay minerals in sandstones; Importance of diagenesis for planning of recovery and production processes. Field trips are required.

Prerequisite: GEOL 532 (or equivalent) or consent of the instructor.

GEOL 650 Clay Mineralogy (2-3-3) The origin, physical and chemical properties, mode of occurrence of clay minerals in natural systems, such as weathering, burial diagenetic & hydrothermal environments. Effects of clay minerals on reservoir properties and on environment and health.

Prerequisite: GEOL 541 or GEOL 532 (or equivalent) or consent of the instructor.

GEOL 660 Depositional Modeling & Reservoir Quality (3-0-3) Introduction to geostatistical concepts and tools for description and modeling of spatial variability in oil/gas reservoirs and other geological formations. Topics include review of basic statistic concepts, exploratory spatial data analysis, stationarity and ergodicity, variogram and covariance, kriging, spatial sampling, stochastic realizations and simulations, conditioning, and indicator kriging.

Prerequisite: GEOL 521 or GEOP 550 (or equivalent) or consent of the instructor.

GEOL 670 Eustacy & Sequence Stratigraphy (3-0-3) Systematic analysis of modern and ancient deposition facies and their interpretation in a sequence stratigraphic context. Integration of well-logs, seismic sections, core, and outcrop analysis will be adapted.

Prerequisite: GEOL 534 or GEOP 535 (or equivalent) or consent of the instructor.

GEOL 680 Organic & Petroleum Geochemistry (2-3-3) Origins, and classifications of organic matter in the geosphere. Modern and ancient processes and environments of deposition of organic-rich strata, including hydrocarbon-source rocks and coals. The role of temperature and time in the maturation of hydrocarbons. The biomarker concept, pyrolysis techniques, isotopes in petroleum exploration, basin modeling and kinetic studies, organic petrography and detailed studies of case histories.

Prerequisite: consent of the instructor.

GEOL 690 Petrophysics and Well Log Interpretation (3-0-3) Acoustic, electric, radioactive and hydraulic properties of reservoir rocks. Well logging tools and modern well-log interpretation. Integration of the logs with outcrop and seismic data to produce comprehensive sedimentologic and stratigraphic models. Clean and shaly formation interpretations are both covered. Computer applications are emphasized.

Prerequisite: GEOP 550 (or equivalent) or consent of the instructor.

GEOL 696 Doctoral Seminar on Advanced Issues in Geosciences (1-0-0) The student is required to attend all seminars organized by the ES Department. Additionally, the student prepares and delivers a fully researched, in-depth Seminar talk on recent Geological theory or controversies, or the latest developments in methodology and laboratory techniques.

Prerequisite: Doctoral graduate standing.

GEOL 701 Directed Research (3-0-3) This course is intended to allow the student to conduct research in advanced problems in his PhD research area. The faculty offering the course should submit a research plan to be approved by the Graduate Program Committee at the academic department. The student is expected to deliver a public seminar and a report on his research outcomes at the end of the course. This course is graded on a Pass or Fail basis.

Prerequisite: Prior arrangement with an instructor.

GEOL 702 Directed Research (3-0-3) This course is intended to allow the student to conduct research in advanced problems in his PhD research area. The faculty offering the course should submit a research plan to be approved by the Graduate Program Committee at the academic department. The student is expected to deliver a public seminar and a report on his research outcomes at the end of the course. This course is graded on a Pass or Fail basis.

Prerequisite: Prior arrangement with an instructor.

GEOL 710 Dissertation (0-0-12) Writing a Thesis Proposal, its public defense, carrying out the field work, analytic work, and statistical analysis of the data, preparing the Thesis, its oral presentation and defense. Students are encouraged, as part of the Thesis preparation, to submit related publications as conference presentations or to peer-reviewed Journals.

Prerequisite: Completed coursework

RESOURCES:

- **Manpower:** The *Earth Sciences Department* has 15 full-time faculty members representing a wide spectrum of theoretical and explorational/engineering aspects of Earth Sciences. Experts from industry and the kfupm/research institute are usually invited to teach part of all of some courses.

Areas of Specialization of ESD Faculty

Geophysical Computations, Geophysical Inversion, Potential Field Theory, Applied Maths; Exploration Geophysics; Shallow Geophysics; Rock Physics; Petrology;
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Minerology; Economic Geology; Geochemistry; Geotectonics; Carbonate Sedimentology; Petroleum Geology; Sedimentary petrology, Structural Geology; Geophys. Engng.; Engng./Envir. Geology; Seismic Exploration; Hydrogeology; Geostatistics; Groundwater Modeling; Water Resources; Clastic Sedimentology; Basin Analysis; Rock Magnetism; Paleomagnetism; Sequence Stratigraphy; Seismic Interpretation; Earthquake Seismology

- The Department has a total of about 110 graduate and undergraduate students. Our Alumni are among the leaders in many private and governmental geosciences-related organizations including Saudi Geological Survey, Saudi Aramco, ARGAS, Schlumberger, Ministry of Petroleum and Minerals, and the new international gas joint ventures.
- Facilities, Equipments, Software The department hosts excellent teaching and research facilities that include XRD, SEM, gravimeter, seismic recorder, GPR, Logitech thin section preparation machine, hydraulic driven augers, portable water quality checker, porosimeter, permeability meters, to name a few. Details are found in the following Tables :

Laboratories of the ESD

Lab title	Objectives	Software/ Major equipments	Location
Structural Geology & Remote Sensing	Instructional Lab.	Stereoscopes	26-250
Hydrogeology & Engineering Geology Lab	Research Lab	Water testing & mineral prospecting	26-208
Mineralogy & Optics	Instructional Lab.	Petrologic Microscopes	26-209
Physical/Historical & Paleontology	Instructional Lab.	Rocks, Mineral & fossils hand specimens	26-102
Scanning Electron Microscope	Research Lab	SEM	26-104
Advanced Microscopy lab	Research Lab	Axiophot Nikon photo microscopes	26-320
Micro paleontology section	Research Lab		26-205
Graduate PC Lab	Instructional & Research	PC's	
Geophysics Lab	Instructional & Research	Seismic & electrical exploration equipment.	26-201
PC Lab	Research & Instructional	PC's, printers	3-108
Faculty PC use (CONTROL ROOM)			3-104
Paleomagnetics Lab	Research Lab		26-323/322
Geology Museum			26 Lobby

List of Equipment

1. RS-232 Spinner- magnetometer (Geophysics, Paleomagnetic studies)
2. MMTD-80 Thermal Demagnetizer (Geophysics, Paleomagnetic studies)
3. EG-1161 Graviton-EG (Geophysics, Gravity and Magnetic)
4. PARM Shielded-Demagnetizer (Geophysics, Paleomagnetic studies)
5. Minisep Magnetic Susceptibility (Geophysics, Magnetic Susceptibility Measurements)
6. EG & GEOMETRICS ES-1225 (Geophysics, Seismic Exploration)
7. BRGM SYSCAL-R2 Resistivity meter (Geophysics, Resistivity measurements)
8. GS DC-2 Ground penetrating radar (Geophysics, Shallow underground studies)
9. U-10 Water quality checker (Hydrogeol.)
10. Flow mate (Hydrogeol., Water flow measurements)
11. z-512 Centrifuge (Geol, Sample preparations)
12. GS-5 GPS (GEOL, GEOP, Global positioning system)
13. 0510-02 Slake durability apparatus (Geol, To study weathering and environmental effects on rocks and soils)
14. RM-735 Point load tester (Geol, To measure stress and strain on rock samples)
15. Schmidt hammer (Geol, Hardness measurements on different types on rocks)
16. JSM-5900LR SCAN ELECTRON MICROSCOPE (Geol)
17. EDS (Geol, Used with SEM to do chemical analysis of a given sample)
18. Sputter (GEOL, Gold coating machine for SEM)
19. Carbon sputter (Geol, Carbon coating machine for SEM)
20. D-7082 Axiophot Photo-Mic (Geol, For rocks and mineral thin-section studies & photo-microscopy)
21. ME -600LNikon-Microscope (Geol, For rocks and mineral thin-section studies & photo-microscopy)
22. DC-300 Microscope Digital camera (Geol, Photo microscopy of thin sections)
23. 65 C Ingram-Compact (Geol, Rocks and mineral thin-section making machine)
24. 38-14s Petro-thin (Geol, Rocks and mineral thin-section system)
25. LU 6X Lapidary combination unit (Geol, To polish rock and mineral samples)
26. P 105 Slab and trim saw (Geol, Sample preparation machine)
27. GSB-90 Drill core (Geol, Sample preparations)
28. Chip-munk Crusher (Geol, Rock and mineral sample preparations)
29. SB-580 Smart board (Geol, Computer aided teaching facility)
30. V870 Visualizer (Geol, Computer aided teaching facility)
31. DVR-7000 DVD PLAYER (Geol, Geoph, Smart class room DVD projection facility)
32. EMP-800 Projector (Geol, Smart class room data show projector)
33. C4704A Plotter (For scientific research posters and presentations)
34. C-6270 HP Scan jet (For scientific research posters and presentations),
35. Ultra 450 Sun server (Geop, Geol, Advanced Geological & Geophysical data processing work station)

- Both graduate and undergraduate students enjoy a state of art PC lab loaded with many specialized software and all of our courses are taught in smart classrooms.